ATTACHMENT O

RECENT DEMONSTRATION PROJECTS FUNDED BY THE IAW PROGRAM

PIR-09-001
INDUSTRIAL ENERGY EFFICIENCY, WATER AND WASTEWATER
Development of Sustainable Infrared Dry Peeling Technology for Tomatoes

Currently, chemical peeling with sodium hydroxide or potassium hydroxide is the standard method for peeling tomatoes as well as canned fruits such as peaches, pears, and apricots. The waste chemicals are normally neutralized and then discharged as wastewater. The high salinity of the wastewater from the peeling process has become a critical issue to the future of tomato and related processes. The management of wastewater and salts in food processing plants is very costly, ranging from $258 to over $8,000 per ton of total dissolved solids. Due to cost and environmental regulations, some tomato processors use steam peeling to reduce chemical contamination of water. Steam peeling produces undesirable products, such as deteriorated appearance, loss in firmness and lowered product yields. Steam peeling is also more energy intensive. Although various alternatives have been studied, no commercially feasible peeling methods have been developed and used.

This project will use Infrared heating (IR) technology. IR dry peeling has the benefits of reducing energy consumption and producing less wastewater while preserving product quality. IR dry-peeling reduces the tomato peeling loss significantly and results in better firmness of the product with similar heating time compared to chemical peeling. The reduced peeling loss and improved product quality mean that more valuable and premium products can be produced. Because no salts are used in the peeling, the skins do not contain added salts and can be easily utilized as value-added food products.

PIR-09-003
INDUSTRIAL ENERGY EFFICIENCY
Advanced Energy Delivery for Food Processing: Direct Steam Generation in Parabolic Trough Solar Collectors

This project is to demonstrate on a pilot scale the ability of Direct Steam Generation (DSG) technology to deliver saturated steam under normal, everyday solar conditions. The goal is to correlate experimental data with theoretical work that will deliver the information needed to scale up from pilot plant to a full scale industrial operation. This project will use and demonstrate the direct steam generation (DSG) technology in the

receiver tube of a line focus parabolic trough collector, first in a single row, and then to simulate operations in multiple rows. From these experiments the goal is to derive the necessary data to scale up the pilot plant to a full scale solar field. Long-term, the outcome of this project is the creation of a new generation of technology that will compete with conventional steam generation in the supply of thermal energy to the California food processing industry.

The commercialization of DSG technology will generate substantial economic activity and reduce energy use and costs while improving environmental quality in terms of reduce air emissions and greenhouse gas production. This project will quantify these benefits and demonstrates that solar thermal technologies could be an important element in meeting California's aggressive environmental goals.

PIR-09-004
INDUSTRIAL ENERGY EFFICIENCY, WATER AND WASTEWATER
Integrated Waste Heat and Water Recovery DOME for Food Processing Applications

California's $50 billion food processing industry is an important, diverse, and dynamic sector of California's economy. This industry is the third largest industrial energy user in the State annually that consumes an estimated 590 million therms of natural gas, 3,700 million kWh of electricity, and 36,000 million gallons of water. Over the past decades urbanization, regulations, higher costs for water, global competition, and limitations on effluents have motivated the food processing industry to search for ways to reduce energy and water use. Being a large consumer of water and energy the food processing industry naturally generates large amounts of waste heat and wastewater that significantly reduces the energy efficiency of the operations and increases its cost. The commercial market offers limited technologies to the food processing industry for waste heat and wastewater recovery.

This project is to develop and demonstrate the cost-effective and efficient DOME technology which is based on a concept of integrated waste heat and wastewater recovery, utilization and/or reuse in an optimal combination of processes governed by Laws of Nature using well-established off-the-shelf hardware components.

In layman's terms, the DOME technology is a distillation vessel that uses waste heat to evaporate waste water from the associated process. The distillation vessel is designed so that the clean condensed water created by the vessel is drawn down by gravity and creates a slight vacuum in the vessel space behind it. This lowers the boiling point of

the wastewater in the DOME device and improves the efficiency of the distillation process. DOME is the name of the process. It is not an acronym.

PIR-09-008
INDUSTRIAL ENERGY EFFICIENCY
Solar Assisted Gas Hot Water Heating for Food Processing Industry

This project is to develop and demonstrate a solar-assisted gas hot water heating system for small food processors. The proposed system combines a low maintenance closed loop solar water heat with high efficiency heat exchanger and supplemental tank-less gas fired water heater. Such a system has the potential for energy cost savings of 40%. This project aims to provide an environmentally sound, safe, reliable, and affordable energy product while satisfying the unique California requirement of smog mitigation through NOx reduction. Solar-assisted systems (added to natural gas fired equipment) would decrease natural gas demand during the summer when the wineries demand for hot water is the highest. This would result in a corresponding decrease in greenhouse-gas emissions proportional to the decrease in natural-gas usage.

Smaller wineries utilize conventional storage tanks that are less than 199 gallons. At 200 gallons the storage tank must be an approved pressure vessel thus adding significantly to the initial cost. If the solar-assisted gas hot water heating system were adopted by the estimated 40% of the California wineries which utilize small tanks, the potential natural gas savings is projected at 16% or 3.7 million therms out of 23 million therms used annually. The corresponding carbon dioxide production would be reduced by 44 million lbs/yr. This project will result in lower energy costs through the more efficient use of natural gas, increase the State's competitive position in global markets, and improve environmental quality.

PIR-09-020
ENERGY STORAGE ON CUSTOMER SIDE OF METER, DEMAND RESPONSE
One-Cycle Control Peak Load Reduction (OCC-PLR) System

The high-cost and complexity of the traditional approach to power conversion have generally resulted in limited deployment of customer-side energy storage. Most energy storage efforts focus on kWh and load shifting, essentially utility-side considerations, rather than peak kW and peak-demand charges for a customer-side consideration. For light-duty industry, a 3-phase bidirectional converter (BDC) is necessary to enable customer-side energy storage peak demand reduction. The bidirectional convertor is

responsible for converting the 3-phase AC supply to DC and back to AC for end-use during discharge. This requires the BDC to have a rapid response time for peak load reduction, with high overall conversion efficiency.

One Cycle Control (OCC) has developed a bidirectional converter that has been commercially available since 2007. OCC will partner with A123 to demonstrate a 15 kW OCC-Peak Load Reduction system with a system response time of less than 4ms. The system will use the OCC bidirectional converter with recycled Hymotion battery pack (currently being used by the Toyota Prius). The demonstration will occur at a light-duty manufacturing site in SCE's service territory, with the potential to have measurement and verification conducted by SCE.

PIR-10-001
ENERGY STORAGE ON CUSTOMER SIDE OF METER, DEMAND RESPONSE
Demonstration of Zinc-Flow Energy Storage System

Lead-acid battery technology currently dominates the energy storage marketplace and is used in nearly all uninterruptible power supply (UPS) application for backup power needs. This technology works ideally when infrequent and short duration backup power is required. However, lead-acid technology cannot be deeply discharged without adversely affecting the battery's life and performance, it is also unreliable and expensive to maintain. Premium Power's Zinc Flow energy storage technology is designed to operate in peak shaving and load management applications where longer duration discharges and frequent cycling are required. Zinc Flow technology offers 30 years of unlimited cycles, 100% depth of discharge, 70% round trip efficiency and is fully autonomous allowing report operation. This project will provide operational experience as well as measurement and validation of the technical and economic performance of the technology provided by a recognized user and supported by one of California's major utilities.

Premium Power, Wal-Mart and San Diego Gas and Electric (SDG&E) will work together to demonstrate the technical and economic performance of a 150kWh Zinc-Bromide (Zn-Br) PowerBlock150 energy storage system (ESS), connected on the customer side of the meter. A successful demonstration of the Zn-Br flow battery energy storage technology at the site would provide critical data that would pave the way for applications at other Wal-Mart stores, other industrial and commercial customers in California and utility sites in California where peak load reduction, load management and demand response is needed, and emissions and noise are a concern.

PIR-10-008
WATER AND WASTEWATER
The Use of Novel Nanoscale Materials for Sludge Dewatering: A Field Demonstration

Wastewater treatment consumes about 2000 million kilowatt hours per year in California. Approximately 40% of this energy use is for sludge treatment and disposal. One reason sludge treatment is energy intensive is the large amounts of energy required to remove water after aeration. Water removal is required to lower the volume to reduce hauling and disposal costs. Facilities ship the sludge hundreds of miles by truck for disposal, which significantly increases the carbon footprint of wastewater treatment in addition to the energy used to dewater the sludge.

The goal of this project is to improve energy efficiency and reduce the carbon footprint of sludge dewatering/disposal during wastewater treatment. This will be achieved using innovative nanoscale additives during polymer-aided dewatering. A field demonstration study will be performed at Los Angeles County Sanitation District (LACSD), Joint Water Pollution Control Plant (JWPCP) in Carson, CA.

The objectives are to:

- Develop and characterize nanoscale additives for dewatering;
- Identify the nanoadditive composition (single or in combination) best suited for different sludges;
- Demonstrate through lab and field studies improvement in energy efficiency during dewatering, reduction in sludge mass (i.e. increase in percent solids) requiring disposal, improvement in supernatant quality, reduction in polymer dose requirement; and
- Develop preliminary cost estimates to show economic viability of the proposed technologies.

PIR-10-011
WATER AND WASTEWATER
CASCADE Clean Energy System for Water and Wastewater

This project will demonstrate the "Computer-Assisted Strain Construction & Development Engineering" (CASCADE) Clean Energy System technology at the Dublin San Ramon Service District (DSRSD) wastewater treatment facility in Dublin, CA. The patented CASCADE technology discovers the predictive relations between genomic fingerprints of an organism and its metabolic capabilities and then uses those relations to look for the best organisms to use in a particular application.

The project will demonstrate that the CASCADE Methane Bioreactor and 1000-gallon digester at DSRSD can improve existing digester efficiency by 30% or more. DSRSD is one of the 1% of facilities that already have digesters to produce methane by a natural digestion process. The produced methane will be used by the onsite fuel cells to generate electricity for the facility.

PIR-10-012
WATER AND WASTEWATER
Advanced Water Treatment Technologies for Onsite Water Reuse

This project will evaluate and test alternative disinfection technologies to chemical treatment at a celery processing plant owned by Duda Farms in Oxnard, CA. These technologies will include ozonated water, ultraviolet light (UV), and advanced oxidation treatment. These technologies will not create the microbial precipitates generated from chemical treatment thereby saving energy used to chill water and conserve fresh water supplies. The number of reuse days for the wash water will be increased from one to two or three, which would be a reduction in water use by 50 to 66.7%. This will correlate to a 50 to 66.7% energy savings for chilling water. For the Duda Farm this will result in a reduction of 3.75 to 5.0 million gallons per year, and over 50,000 kilowatt hours per year. There will also be downstream benefits by reducing loading to wastewater treatment facilities or landfills. This project will test these technologies against chemical disinfection by evaluating energy and water consumption and demand, wastewater generated and operating costs. For this project, Southern California Edison will provide the measurement and verification of on-site energy saving as well as work with the project team to determine the economics of the system.

PIR-10-013
DATA CENTERS
Data Center Economizer Cooling with Tower Water

There is an expectation that air used to cool IT equipment should be cooled within the ASHRAE recommended range with an upper limit of 80.6°F, typically a range of 70°F - 75°F is used during design requiring chilled water to be at least 48°F wet-bulb. This range tends to "over-cool" the data center requiring more energy than necessary. Taking advantage of the higher recommended ASHRAE temperature will enable partial or full cooling to be provided with higher temperature cooling tower water.
American Power Conversion (APC), a Schneider Electric Company, is a leading supplier of data center power and cooling equipment. They have designed a secondary air to water cooling coil which is in series with the normally designed chilled water coils

mounted in the computer room air handlers (CRAH). This secondary coil can use cooling tower water to provide partial or full data center cooling at the higher ASHRAE range. The effectiveness and reliability of this technology must be demonstrated and independently verified before market acceptance of the technology.

Lawrence Berkeley National Laboratory (LBNL) will partner with APC to demonstrate the technology at an LBNL data center. LBNL and APC will develop a measurement and verification plan of the thermal performance and energy savings using this technology while providing reliable and controlled cooling for the IT equipment keeping within its specifications. This project aims to show how tower water cooling can eliminate many hours per year of chiller operation in order to speed adoption of this energy efficiency strategy.

It is estimated that reduced chiller operation can reduced data center electricity consumption by 15%, with a potential total savings of approximately 854 million kWh and save data center operators $102 million in electricity costs.

PIR-10-016
WATER AND WASTEWATER
Integrated system for reducing water consumption and wastewater discharge of biodiesel production facilities in California

Biodiesel is a clean-burning, renewable fuel produced from agricultural sources (such as vegetable oils and animal fats) that can be blended at any level with petroleum diesel and used by most compression-ignition (diesel) engines with few or no modifications. The biodiesel industry in California is growing rapidly, with total production by California facilities is currently estimated at 47 million gallons per year. This increase in biodiesel production brings with it associated concerns about potential increases in water consumption and wastewater discharge related to its production. Conventional biodiesel production processes require a water wash step to remove polar impurities (i.e., glycerol, soaps, methanol and salts) from the crude biodiesel product. Between 0.4 and 2 gallons of wash water are typically utilized for every gallon of biodiesel processed, and the spent wash water constitutes a waste stream high in biological oxygen demand (BOD) and total dissolved solids (TDS).

While “waterless wash” systems have been proposed for biodiesel production (i.e., using a solid adsorbent instead of water to remove impurities from the crude biodiesel), drawbacks include the consumption of costly adsorbent material, added operational complexity, increased hazard of explosion, inadvertent product loss, and the need to dispose of spent adsorbent. While water washing remains the most effective and

economical method of removing polar impurities from crude biodiesel, technologies that mitigate the issues of high water consumption and wastewater generation need to be developed.

The proposed water treatment system will integrate three distinct components consisting of consisting of distillation, ultrafiltration and reverse osmosis technologies, for treating and recycling spent biodiesel wash water. This system will reduce the consumption of water for biodiesel washing by an estimated 85% and result in a zero-discharge wash process. It will constitute the first industrial-scale demonstration of these combined technologies applied to treating effluent from biodiesel production.

PIR-10-017
WATER AND WASTEWATER, INDUSTRIAL ENERGY EFFICIENCY
Supercritical CO2 Cleaning and Sterilization of Commercial / Industrial Textile

Commercial / industrial laundry has long been one of the major water consumers and uses billions of gallons of potable water each year. While the industry has implemented water efficiency measures thus far there have been no outright substitute solvents introduced which offer environmental, performance and cost benefits over water. The environmental impacts of implementing technology which does not utilize water as a cleaning solvent are enormous. CO2Nexus has developed a commercial prototype supercritical carbon dioxide-based laundry system for industrial/commercial laundry facilities that will reduce water consumption and significantly reduce energy usage through the elimination of the associated dryers. In order for market acceptance, the technical and commercial feasibility of a supercritical-carbon dioxide textile cleaning and disinfection machine must be demonstrated with independent verification of the energy and water savings.

This project aims build the first commercial supercritical-carbon dioxide textile cleaning machine to document and validate:

- Real world cleaning performance across different industrial/commercial textiles, fabrics and surfactant formulations;
- Machine operating specifications including utilities (e.g. energy) consumption; cycle time; operability and workflow; component reliability; sterilization/disinfecting capabilities;
- Benchmarking of all relevant performance/cost criteria vs. incumbent water.

The demonstration site will be ARAMARK’s Cleanroom service facility in the Los Angeles area, this technology is applicable to a wide variety of end users including but

certainly not limited to: industrial laundries, industrial textile cleaning, prisons, nursing homes, universities and hotels. California has approximately 8800 such facilities, this technology has the potential of saving 264 GWhr (5% market penetration), save 20 million therms and over 600 million gallons of water use by the industry.

PIR-10-018
INDUSTRIAL ENERGY EFFICIENCY, DEMAND RESPONSE
Advanced Software for Demand and Energy Reduction in California Pipelines

Fluid pipelines operating in California transport gasoline, fuel oil, jet fuel, crude, other hydrocarbons, and water, all vital to the wellbeing of California's economy. These pipelines are also significant users of energy, in the form of electricity and natural gas used to run the pumps necessary for pipeline operation. In addition to significant baseline energy consumption, additional energy usage is often required by pipelines to respond to pipeline schedule requirements.

This project will demonstrate the energy savings possible with use of pump optimization software and use of drag reducing agents (DRA). mc2 will retool their existing pump optimization software to provide an integrated software solution to determine:

- Optimal pump selection (electric or natural gas engine-driven) and sequence for specific fluid
- Optimal DRA concentration profile based on fluid transported
- Identify or forecast scheduled periods of high pipeline flow and energy use to optimize the schedule to reduce those periods while maintaining throughput requirements.

This technology has the potential California-wide energy savings of 23 GWhr /year, coupled with a conservatively estimated 50 MW in demand reductions, and 5 thousand therms/year gas use reduction. For this project, Pacific Gas and Electric will provide the measurement and verification of all energy savings for this project.

PIR-10-021
WATER AND WASTEWATER
Reclamation of Wastewater for Cooling Tower Operations at the Gills Onions Processing Plant in Oxnard, California

Commercial membrane filtration is used worldwide in the chemical and biotechnology industries to concentrate streams and maintain product quality in manufacturing. It has also been established as a viable and economical means of filtering and cleaning wastewater and industrial process water for discharge, irrigation, or other reuse options. Although, this technology is becoming increasingly common in municipal water and wastewater treatment, the proposed project will demonstrate the cost and energy effectiveness when applied to the scale and waste streams in the food processing industry. Operational data are needed to demonstrate the application of this technology in the CA food processing industry for proving its potential to save the state's precious water and reducing water conveyance energy demands. It appears that no food processing plants in California are utilizing membrane filtration of wastewater for reuse.

This project will demonstrate the effectiveness of a commercially available membrane filtration system to clean and reuse wastewater produced from the Gills Onions onion processing plant (the world's largest year-round grower and processor of fresh-cut onions) for supplying evaporative cooling towers used in the plant. If successful, this will reduce demand for fresh city water by about 45,000 gallons-per-day (GPD), decreasing volume impact on the sewer system and reducing water conveyance energy demands (i.e., energy associated with delivering water to and carrying wastewater from the onion processing plant).

PIR-10-022
DATA CENTERS
Variable Airflow Management with Direct Expansion (DX) Computer Room A/C

A large fraction of the data center cooling equipment in existing data centers are Direct Exchange refrigerated based Computer Room Air Conditions (DX CRAC) units. These DX units currently do not use variable speed drive (VSD) control technology on their fans. The often-cited argument is that the cooling loads in data centers remain relatively unchanged and variable frequency drives are not economically justified. This argument was debunked in a 2004 large-scale data center for Oracle in Austin, TX. In the Oracle demonstration, VSDs on chilled-water CRAC units were implemented with a payback period of 6 months. Use of VSDs in chilled-water CRAC units is now accepted in the industry. In order to extend use of VSDs on DX CRAC units, a demonstration similar to Oracle for chilled water CRAC units is needed to provide the performance, reliability and economic data for market acceptance.

This project will demonstrate the effectiveness of airflow management with retrofit of VSD to existing DX CRAC units along with a distributed wireless mesh temperature sensor network in data centers to control VSD operation. The demonstration will be at

EPRI's own data center and at NetApp's data center in Sunnyvale. Successful demonstrations at these two locations will provide the necessary performance, reliability, and economic data necessary to overcome information barriers for adoption by the industry. It is estimated that use of VSDs with the wireless sensor network can reduce data center electricity consumption by 15%, with a potential total savings of approximately 854 million kWh and save data center operators $102 million in electricity cost each year.

PIR-10-020
DATA CENTERS
High Efficiency Server Fans

Rack servers used in data centers produce a lot of heat, and require internal cooling fans to cool Central Processing Units (CPUs) and other components. These fans use significant energy to operate, power that is parasitic in that it does not go towards any actual computing task. The recipient has developed the PAX Streamlining Principle, a technology based on principles of fluid movement found in biological systems. The PAX Streamlining Principle, when applied to fan blade geometries, creates fans that are more energy efficient and quieter (noise is wasted energy) than fans designed by conventional means. The recipient has designed fans that are best-in-class for other applications such as residential refrigeration and heating, ventilation and air conditioning (HVAC) condenser fans, in which its designs dropped power usage by 20-30% and also lowered noise significantly.

The information technology (IT) industry builds systems using a procurement process that tries to squeeze out cost on every component. Since conventional fan technology is not significantly differentiated among suppliers, there is little room to garner value from a more efficient fan product in a procurement process that does not recognize the unique performance of the recipient's fans. This project seeks to generate independent data to support the claim that the recipient's technology can design more energy efficient fans, and to overcome the procurement hurdle by elevating the exposure of the technology to the original equipment manufacturers

The goal of this project is to promote greater energy efficiency in server cooling by demonstrating the increased efficiency of fans designed using the PAX Streamlining Principle. The goal is to reduce fan power consumption by at least 15%.

The objective of this project is to demonstrate that a server retrofitted with the recipient's designed cooling fans could use 15% less energy.

PIR-10-023
ENERGY STORAGE ON CUSTOMER SIDE OF METER, DEMAND RESPONSE
Application of High Capacity Electric Energy Storage via Vanadium Redox Flow

Batteries, in Conjunction with Fuel Cells, to a Wastewater Treatment Facility

Energy storage systems will become increasingly necessary to address intermittent supplies of power available from renewable sources as California strives to reach the Renewable Portfolio Standard goal of 33% renewably generated electricity by 2020. The main barriers to market adoption of energy storage systems are their high costs and current limited uses. Expensive energy storage systems are used primarily for peak-shaving applications, which are often limited of economic value.

This project with Utility Savings & Refund, LLC will demonstrate the increased value of energy storage systems when they are combined with on-site fuel cell power generation. The Dublin/San Ramon Services District's Regional Wastewater Treatment Facility in Pleasanton, California, currently uses two 300 kW molten carbonate fuel cells that are operating on renewable anaerobic digester gas. The proposed project integrates a 3.6 MWh vanadium redox flow battery (VRFB) energy storage system with the existing fuel cells. This will not only store intermittent renewable energy from the grid but has the added benefit of addressing fuel cell sizing and nuisance trips, two key issues associated with fuel cell use.

High-performance fuel cells are typically undersized compared to a facility's mid and peak loads owing to the lack of turndown on the fuel cells. A VRFB energy storage system has the ability to store hours of energy, this system would allow for the installation of fuel cells with capacities in excess of the base load. The result would be increased on-site renewably generated power and a decreased demand for power from the grid, particularly during peak hours. Fuel cells can also go off-line several times a month in what are called "nuisance trips", which occur due to power quality problems or when power demand dips below fuel cell capacity. An on-site VRFB energy storage system would be able to respond quickly to variations in generation and power quality, resulting in reduced "nuisance trips". This will increase the efficiency of the fuel cells and decrease demand from the grid, resulting in lower energy costs.

PIR-10-046
INDUSTRIAL ENERGY EFFICIENCY (On-site anaerobic digestion)
Fiscalini Farms Renewable Energy Research Project

This project is an analysis of the efficiency, effectiveness, and regulatory compliance of a renewable energy system for power generation using alternative fuels as feedstock in a dairy anaerobic digestion power generation system on the Fiscalini Farms, L.P. dairy in the San Joaquin Valley of California. The proposed project is to provide data proving the combination of European technologies for anaerobic digestion and power generation will operate effectively, efficiently, and economically while meeting the strict

environmental regulations of California utilizing multiple feed stocks. This project proposes to demonstrate the system will generate greater volumes of biogas using the multiple feedstocks, increased power generated for an acceptable economic return on the investment, and compliance with environmental regulatory requirements. These results will improve the ability to commercialize these technologies in California and the US, provide the necessary technical data to regulatory agencies to increase the predictability of public policy, and facilitating the permitting process of anaerobic digesters. Improving this process will encourage more dairy operations to consider the installation of this type of system.

PIR-10-052
DATA CENTERS
Data Center Energy Efficient Cooling Control Demonstration

This project will demonstrate cooling control technology integrated with wireless network sensors to control data center cooling, combined with best practices. This technology includes intelligent control software and wireless mesh network sensing for direct feedback of server inlet air temperature and control of variable frequency drives (VFDs) for the fans of the computer room air conditioners. The project includes a data center best practice of retrofitting computer room air handling (CRAH) units with VFDs to modulate fan operation, along with hot/cold aisle containment, rack blanking, and moving perforated floor tiles. Combined, these measures can improve air distribution resulting in better temperature control while achieving dramatic energy savings. The wireless mesh-network feedback is used as input to the control software that automatically determines which cooling units to operate and resets operating set points of the cooling units.

Federspiel Controls is partnering with the California Department of General Services. The project will demonstrate the technology at a total of 9 state owned data centers located in Los Angeles, Sacramento, and San Francisco. It is anticipated that by the time of the execution of this agreement, 5 to 7 of the total 9 data centers will still require work to complete the retrofits. The demonstration at these data centers will help accelerate the market transformation of data center energy management in California, which will stimulate the California economy by both creating jobs installing and maintaining the technology and also help ensure California's leadership position in the information technology industry.

The Energy Commission cost sharing will be used to pay for direct labor, fringe benefits, and indirect overhead.

It is expected that this intelligent supervisory control and wireless mesh network sensing system, combined with air management best practices, will be directly applicable to a wide range of localized, mid-tier, and enterprise data centers such as those operated by the State of California. It is estimated that this project could reduce data center cooling energy use by 26 percent.

PIR-10-057
DATA CENTERS
SeaMicro Volume Server Power Reduction Research and Development

SeaMicro has developed a prototype, innovative compute appliance that is currently in beta testing with customers. The PIER funding, coupled with the ARRA grant and match funding, will be used to:

- Accelerate development engineering and quality assurance testing
- Enhance dynamic power-management software to further drive down power draw
- Accelerate product availability
- Accelerate market adoption by reducing cost and modifying the system to address markets beyond volume servers, such as volume servers working on less-common workloads and mid-range and high-end servers.

The prototype appliance redesigns the volume server with more efficient CPUs and achieves over 75 percent reduction in power consumption per computation for the primary workload in the data center. The compute appliance addresses the following issues concerning the inefficiency of the CPU within volume servers:

- Different and varying workload requirements by the CPU due to the internet.
- Inefficiency in server packaging that left enormous duplication in components.

Using the U.S. EPA's estimated energy use for data centers of 61 billion kilowatt-hours/ year in 2006, the estimated energy savings in California would be 3.7 billion kilowatt-hours/ year, based on 80% of volume servers used for web-tier workloads, 68% of energy in the data center used for powering and cooling data centers, and 15% of national data center floor space located in California.

PIR-10-058
DATA CENTERS
Development of Very Dense Liquid Cooled Compute Platform

Clustered Systems proposes to develop a prototype Very Dense Liquid Cooled Compute Platform. The prototype will consist of two server racks each with twelve shelves housing a minimum of 144 modules. The application of liquid cooling to this rack design will achieve a 17 to 45 percent reduction of energy used for cooling compared to air cooling.

The server racks will contain twelve shelves that can house a minimum of 144 modules. The racks will be four times as dense as a typical air cooled rack, and will have a cooling capacity of up to 200 kilowatts. A module is a server redesigned without cooling fans and consists mainly of 2 multi-core CPUs with memory storage and is stacked vertically on a shelf. The elimination of cooling fans will reduce the energy used by a typical server by 10 percent. Without needing to power the server fans, the server power source can be downsized. The energy to pump the coolant increases facility energy by 2 percent, but it is outside the server. The modules will use heat risers to conduct heat from the CPUs, power source and other hot spots to flexible cold plates that have cooling liquid pumped through them fastened to the top. The cooling liquid is a common refrigerant connected to a heat exchanger connected to a chiller or cooling tower.

The energy savings were determined using a modeling tool to compare the Very Dense Liquid Cooled Compute Platform with an optimally designed and operated air-cooled data center in San Mateo, California and showed a 17 percent reduction in cooling energy. Compared to more common, less efficiently run data centers, the liquid cooled racks could reduce cooling energy by up to 45 percent.

In addition to energy savings, the use of liquid cooling reduces floor space needed for servers. Removing large ducts and fans required to move large volumes of air will allow more freedom to place IT equipment closer together. Plus removing the 8 to 12 server fans will reduce the size of the server by 20 percent. These space savings combined with the reduction in energy use can reduce the annual cost of running a data center per server by 36 percent for new construction.